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Title: SAS-085 C2 Agility Model Validation Using Case Studies

Topic 2: Approaches and Organization
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Eight case studies including ISAF mission, Rwanda Genocide, Haiti Earthquakes, and Major Olympic Events were conducted to validate and improve our understanding of the the SAS-085 C2 Agility model. The C2 Agility model consists of two major concepts: 1) C2 Agility – "the ability to transition from one approach to an appropriate approach that can cope with the endeavour's level of complexity (SAS-085, draft)" and C2 Approach Agility – "the size and shape of the region of Endeavor Space where the approach in question can be successful (SAS-085, draft)" or the agility of a particular C2 approach as defined by six agility enablers: flexibility, responsiveness, versatility, adaptiveness, resilience, and innovation.

Reports, interviews, and media were used to complete a case study template that provided a systematic way of capturing evidence for agility. An 'evidence' table was completed for each case study, and a meta-analysis was conducted by looking across the evidence tables, where thirteen common findings were identified (e.g., flexibility as a contributor to agility). Also fifteen new findings were discovered and subsequently used to refine the C2 Agility Model (e.g., the role of leadership in achieving and maintaining agility).

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1. Introduction

Complex Endeavours have caused national and multinational interagency (including military) collectives to investigate better approaches to Command and Control (C2). C2 Agility has been postulated to be necessary for a collective to determine the most effective and efficient C2 Approaches for operations with varying complexity.

The North Atlantic Treaty Organization (NATO) Research and Technology Organization (RTO) Systems Analysis and Studies (SAS) Panel has commissioned several Research Task Groups (RTG) to study the changing face of Command and Control over the years. The most recent RTG SAS-085 entitled "C2 Agility and Requisite Maturity" has a mandate to develop a C2 Agility model that provides clear understanding of agility in a C2 context and yields recommendations for improving C2 approaches for NATO and their allies. The first of three SAS-085 Technical Activity Proposal objectives is "to understand and validate the implications of C2 Agility (or a lack of C2 Agility) for NATO missions by improving the breadth and depth of our understanding of C2 Agility (SAS-085, 2009)." This paper focuses on C2 Agility Model validation using historical case studies involving complex endeavours.

Validation is a key step towards having a reliable C2 Agility Model upon which researchers, educators, and decision-makers may be confident and conduct research, write curricula, and make decisions. Case studies explore real-life endeavours that NATO and their member nations have been involved in and evidence is sought that may prove or disprove pre-conceived notions or hypotheses related to the model's concepts being explored. Meanwhile experimentation provides generic, yet controlled settings needed to fully understand key relationships between C2 Agility Model variables.

The advantage of case studies is that any conclusions drawn from the analysis pertain to real situations, thus case studies provide 'face' validity. The disadvantage of case studies is that these conclusions pertain only to those situation(s) being analyzed, and therefore it becomes difficult to generalize and extrapolate to other situations. On the other hand, experimentation may yield statistical significance, and in theory the results may be generalized across all situations. And so, the two approaches combined will provide both 'face' and 'empirical' validity thus providing even more confidence in the model.

2. C2 Agility Model in Brief

"Agility" is used in many contexts: sports, animal movements, and now organizations and command and control structures. Research into C2 Agility flowed naturally from RTG SAS-065 entitled "NATO Net-enabled capability Command and Control Maturity Model (N2C2M2)" where a collective (several organizations or entities coming together to address a complex endeavour) was said to be "C2 mature" if it was capable of executing multiple C2 Approaches that were increasingly more net-enabled or edge-like (SAS-065, 2010).

Five C2 Approaches were identified: Conflicted, De-conflicted, Coordinated, Collaborative, and Edge. Conflicted C2 was an undesirable C2 approach to have in the collective's "C2 toolbox". However, it was quickly realized that De-conflicted C2 was appropriate for certain known, less complex situations while Edge C2 was needed from the most complex situations. Thus, the collective needed to be agile and adopt the appropriate approach for the given level of complexity. Moreover, SAS-065 noted that as the collective moved from De-conflicted C2 to

Edge C2, each approach became more agile, exhibiting higher values of flexibility, adaptiveness, responsiveness, versatility (formerly robustness), resilience, and innovation (Alberts & Hayes, 2003). And so, Agility appears in two contexts for N2C2M2: that is, 1) agility as the ability to transition from one approach to another based on situation complexity, and 2) the agility of a particular C2 Approach. As mentioned previously, SAS-085 was given the task to crystallize the meaning of Agility within C2 Approaches and Maturity Model contexts.

C2 Agility Model consists of two major concepts:

- C2 Agility – "the ability to transition from one approach to an appropriate approach that can cope with the endeavour's level of complexity (SAS-085, draft)"; and
- C2 Approach Agility – "the size and shape of the region of Endeavour Space where the approach in question can be successful (SAS-085, draft)" or the agility of a particular C2 approach as defined by six agility enablers: flexibility, responsiveness, versatility, adaptiveness, resilience, and innovation.

These definitions are filled with concepts and components that cannot be completely explained in this short paper. Although some of the concepts and components come from previous publications, SAS-085 will publish a full report that will contain a full description of the model as well as all the details of the case study validation. Table 1 is a summary of the model's concepts and components, which in turn provide guidance for case study analysts as they seek evidence from source documents. Note that Table 1 provides not only definitions for each concept and component but also their expected range of values.

Table 1: C2 Agility Model Concepts and Components Definitions

Concept/Component	
C2 Agility	*C2 Agility* is the capability to successfully effect, cope with and/or exploit changes in circumstances enabling transition to the most appropriate region of the *C2 Approach Space* as a function of the *Endeavour Space* characteristics.
Endeavour Space Complexity (SAS-065, 2010)	The *Endeavour Space* may be characterized by the following dimensions: • Effects Space (Political Military, Economic, Social, Information, Infrastructure, diversity (competency, cultural, values) of entities) • Dynamics (time pressure, stability) • Uncertainty (predictability, familiarity) • Risk (likelihood, consequences) • Number of entities and their relationships • Cognitive Complexity (smart adversaries, degree of intent) The *Endeavour Space Complexity* values are identified as **low**, **medium**, and **high** for any of these dimensions or for the Endeavour Space in general.
Appropriate (Required) C2 Approach (SAS-065, 2010)	The *Appropriate* or *Required C2 Approach* depends on the Endeavour Space Complexity. By extension, one can determine the *Required Allocation of Decision Rights*, *Required Distribution of Information*, and *Required Patterns of Interaction*, or use the representative C2 approach labels.
C2 Approach Space (SAS-065, 2010)	*C2 Approach space* is defined by three primary dimensions: • *Allocation of Decision Rights (ADR)* • *Distribution of Information (DI)* • *Patterns of Interaction (PI)*
Allocation of Decision Rights	"In a collection of entities, the allocation of decision rights reflects the actual rights exercised by the entities in a complex endeavour. This allocation can be the result of explicit or implicit laws, regulations, roles, and practices or it can be as a result of emergent behaviour. The allocation of the rights of participating entities to the

	collective can likewise be explicit, implicit or emergent. An allocation of a right to the collective refers to the degree to which individual entities have given up their respective rights for the benefit of the endeavour as a whole (SAS-065, 2010)." *ADR* varies from **None** to **Broad**.
Distribution of Information	"The distribution of information across participating entities refers to the extent to which the information needed to accomplish required tasks is available to each participant (SAS-065, 2010)." *DI* varies from **None** to **Broad**.
Patterns of Interaction	Patterns of interaction between and among participating entities are a function of their respective abilities and willingness to interact as well as the opportunities they have as a result of the actual occurrence of interactions and collaborations. Interactions are enabled and their quality is enhanced by the ability to have (face-to-face or virtual) meetings, the connectivity of the infostructure, and the degree of interoperability that exists between and among a set of participants (technical, semantic, and cooperability) (SAS-065, 2010)." *PI* varies from **Constraint** to **Unconstraint**.
Actual C2 Approach	The *Actual C2 Approach* depends on the region of the *C2 Approach Space* (*actual ADR*, *actual PI*, and *actual DI*) that the entity occupies for the given period of time, or phase of the operation. SAS-065 defined five representative C2 Approaches and their respective ADR, PI, and DI values: • **Conflicted** C2 Approach • **De-Conflicted** C2 Approach • **Coordinated** C2 Approach • **Collaborative** C2 Approach • **Edge** C2 Approach Actual C2 Approach values are indicated by these representative approaches.
Self-Monitoring	*Self-Monitoring* is an executive function where the collective must monitor and track the *Endeavour Space Complexity* and determines whether their *Actual C2 Approach* matches the *Appropriate or Required C2 Approach*. If not, the collective must take the appropriate steps to change their *Actual ADR*, *DI*, and *PI* to match the *Required ADR*, *DI*, and *PI*.
C2 Approach Agility (Alberts & Hayes, 2003)	*C2 Approach Agility* is the agility of a particular C2 Approach described in terms of the six enablers or components. For example the agility of *De-conflicted C2 Approach* would be **low**, while *Edge C2 Approach Agility* would be **high**. Six components have been identified: • *Flexibility* • *Adaptiveness* • *Responsiveness* • *Versatility* (formerly Robustness) • *Innovativeness* • *Resilience* Component values would be identified as **low**, **medium**, and **high**. Sometimes there was evidence for the lack of C2 Approach Agility and its components. Analysts were encouraged to apply the ordinal scale to the opposite component if this was the only evidence available.
Flexibility (*Lack of Flexibility*)	Flexibility: "The ability to employ multiple ways to succeed and the capacity to move seamlessly between them (Alberts & Hayes, 2003)."
Adaptiveness (*Lack of Adaptiveness*)	Adaptiveness: "The ability to change work processes and the ability to change the organization (Alberts & Hayes, 2003)."
Responsiveness (*Lack of responsiveness*)	Responsiveness: "The ability to react to a change in the environment in a timely manner (Alberts & Hayes, 2003)."

Versatility (*Lack of Versatility*)	Versatility (Robustness): "The ability to maintain effectiveness across a range of tasks, situations, and conditions (Alberts & Hayes, 2003)."
Innovativeness (*Lack of Innovativeness*)	Innovativeness: "The ability to do new things and the ability to do old things in new ways (Alberts & Hayes, 2003)."
Resilience (*Lack of Resilience*)	Resilience: "the ability to recover from or adjust to misfortune, damage, or a destabilizing perturbation in the environment (Alberts & Hayes, 2003)."

3. Case Study Plan

SAS-085 conducted both case studies and experimentation to validate the concepts – similar to SAS-065 (SAS-065, 2010). The Case Study data collection and analysis plan provides specific objectives, methodology, categories, and analyses. Due to many C2 Agility Model concepts to be explored and the limited time for this task group, there are still concepts yet to be fully validated. However, it is hoped that this paper provides sound validation methods as the basis for future studies.

a. Case study objectives

The objective for each case study is to seek evidence for the C2 Agility Model, its concepts, components, and their relationships. Case Study leads and their analyst teams were asked to focus on agility components of C2 Approaches that were employed for a given situation complexity level (i.e., C2 Approach Agility). Also, the case studies investigated how a C2 Approach might change as the situation complexity changes (i.e., C2 Agility).

Hence, the SAS-085 case studies are both a crucial and an integral part of the overall validation. The case study findings provide enough information to help the readers understand the context and support the development of vignettes that help communicate evidences for the C2 Agility concepts. On the other hand, the case studies do not describe all aspects of Command and Control (e.g., situational awareness, decision-making, planning, assessment, execution, etc.) unless these aspects help identify the C2 Agility model variables and their relationships.

b. Case study methodology

The case study methodology was to propose candidate case studies, develop a case study template, conduct an analysis that identifies evidence for concepts and components within each case study, and perform meta-analyses across all cases searching for common and unique results.

The SAS-085 case study sub-group developed a template for the capture of evidence. The template became the primary tool for capturing source data and expressing them in terms of the model (Table 2). The template consists of ten main parts beginning with an executive summary so that the reader may get a sense of the case study without going through the entire text. Part II identifies the level of analysis, temporal phases, and other boundaries. Part III briefly summarizes the situation that would give rise to a particular C2 Approach and C2 Agility. Part IV provides some words regarding the consequences if the appropriate C2 Approach or C2 Agility were not adopted. Part V encapsulates high-level statements on whether C2 Approach Agility and C2 Agility were manifested in the case. Parts VI and VII lists evidence for C2 Approach Agility and C2 Agility, respectively. Part VIII recounts any interesting vignettes from the case that might clearly illustrate C2 Approach Agility, C2 Agility, or both. Parts IX, X, and XI are the Assumptions, Conclusions, and Bibliography, respectively. The case study teams

acknowledged upfront that the template was a living document and subject to change. For the most part, the analysts were able to work with this high level structure.

Table 2 Case Study Template
(Italicized text was added to align the template with the latest iteration of the C2 Agility Model).

I. Executive Summary a. Focus and Boundaries b. Challenge or Opportunity for *C2 Approach Agility and* C2 Agility c. Was Agility Manifested? If so, How? d. Enablers and Inhibitors of C2 *Approach* Agility e. Summary of Observations/Conclusions about C2 Agility f. Important stories or vignettes in the case study.
II: Identify the Focus of and the Boundaries for the Case Study a. What is the level of analysis? (e.g. Individual, Team, Organization, or Collective) b. Who or What Organizations are included in the case study? (e.g. the Collective responding to the Haiti Earthquake Crisis, Air-Ground Control Strike Teams in Iraq and Afghanistan) c. What temporal boundaries are included? a. When does the case begin and end? b. Are there phases involved? If so, what are their boundaries? d. Other boundaries (e.g. separate analyses of the collective and of specific organizations within the collective).
III. Describe the Challenge or Opportunity that gave rise to the need for *C2 Approach and* C2 Agilities.
IV: What would have been the consequences of a failure to act in a way that demonstrates *C2 Approach Agility and* C2 Agility?
V: Was *C2 Approach Agility and* C2 Agility Manifested? If so, How? (Be as clear and precise as possible, but keep this simple so that it does not require repetition in the next steps.)
VI: Which Enablers and Inhibitors of C2 *Approach* Agility were observable? (Remember that the basic six may not be independent. Include discussions of the relevant Agile Behaviors, but try to tie them to one or more Enablers. Specify inhibitors that impacted C2 Agility)
VII: What C2 Approaches were relevant *(i.e., did different situation complexity levels require a corresponding different C2 Approach)*? (How can C2 Agility be inferred from what was reported or observed?) Did C2 Approach change *to the appropriate C2 Approach*, either for a collective, organization, team or one or more individuals?
VIII: What interesting and important vignettes are included or can be derived from the case study to help create illustrative stories?
IX: Case Study Assumptions and Limitations: a. What constraints did you encounter that might limit the case study or the evidence supporting it? b. What assumptions did you make when carrying out or documenting the case study?
X: Conclusions a. This is not a summary – that is in the Executive Summary b. Conclusions relate to the purposes of the case study a. Enablers, Constraints, and Behaviors identified b. Language – Clarity and Definitions c. Applicability of the SAS-085 Concepts and Model d. Statements about Validity
XI: Bibliography

c. Case study Categories

Candidate case studies were proposed that highlighted key aspects of the overall C2 Agility conceptual model. Candidate case studies included complex endeavours that involved a collective ('coalition of the willing') with problems to solve or situations to stabilize. The chosen complex endeavours included complex battlespace (Helmand Province and NATO

Operations), peace-keeping operations (Rwanda), cyber warfare (Estonia and Georgia), disaster relief (Garda and Haiti Earthquakes), and major events (Munich and Vancouver Olympics). These candidate case studies contain a wide variety of situations with changing levels of complexity and a group of organizations ready to tackle the problems. SAS-085 members volunteered to lead one or more of the case studies.

The following is a list of cases that were studied to find evidence for C2 Approach Agility and C2. Each is given a letter name for the reader to track through the analyses, however, the findings for only a subset of cases are reported for brevity sake.

Complex Battlespace

A. Helmand Province 2010/11
B. Comprehensive Approach in NATO Operations

Peace-keeping

C. Rwanda Genocide 1994

Cyber Warfare

D. Estonia Cyber Attack 2007
E. Georgia Cyber Attack 2008

Natural Disasters

F. Garda Earthquake 2004
G. Haiti Earthquake 2010

Major Events

H. Munich Olympics 1972
I. Vancouver Olympics 2010

d. Case study analyses

The objectives for the analyses are to 1) find evidence for C2 Agility and C2 Approach Agility, thus providing 'face' validity for the C2 Agility Model, and 2) determine the characteristics of C2 Approach Agility and C2 Agility that were common amongst the cases being studied, as well as to highlight new and unique concepts and components that may be used to refine the model.

Case study analyst teams were asked to use the evidence collected in the templates and complete Table 3. Table 3 provides a 'tick box' method to record evidence for C2 Agility, Endeavour Space Complexity, Appropriate (Required) C2 Approach, C2 Approach Space, ADR, DI, PI, Actual C2 Approach, Self-Monitoring, C2 Approach Agility, Flexibility, Adaptiveness, Responsiveness, Versatility, Innovativeness, and Resilience.

All case studies were divided into temporal phases as indicated by the Table columns. It was left up to case study analysts to decide how best to divide the case study into phases. Also, analysts had the option to enter into a table cell some indication of the existence of the concept (e.g., a check mark), a pre-determined categorical or nominal label (e.g., Conflicted) or an ordinal value (e.g., low) as applicable. There is sufficient latitude in completing Table 3 in recognition that the case study data sources are likely to have only indirect and interpretive evidence for many of the concepts, and so it is expected that definitive evidence will be rare for many of the concepts and components. Table 3 is filled with fictional data for illustrative purposes.

Recall that second analysis objective is to determine concepts and components that are common across all case studies, as well as capture any new concepts that that have emerged from any of the case studies. Table 4 column 1 lists the concept or component name. The first sixteen rows are identical to Table 3 column 1, and the last few rows will have the new concepts listed identified by the case study analysts. Table 4 column 2 contains case study I.D. letters.

Table 3: Generic Case Study Evidence Table with Fictitious entries for example purposes

Concept/Component	Phase 1	Phase 2	Phase 3
C2 Agility			
Endeavour Space Complexity	High	Medium	Low
Appropriate (Required) C2 Approach	Collaborative	Coordinated	De-conflicted
C2 Approach Space			
Allocation of Decision Rights	Somewhat broad	Narrow	Narrow
Distribution of Information	Broad	Broad	Not as Broad
Patterns of Interaction	Constrained	Constrained	Constrained
Actual C2 Approach	Between Collaborative and De-conflicted	Between Coordinated and De-conflicted	Closer to De-conflicted
Self-Monitoring	None	√	√
C2 Approach Agility			
Flexibility	√	?	?
Adaptiveness	√	√	?
(Lack of Responsiveness)		High	?
Versatility	√	√	?
(Lack of Innovativeness)	√	√	Low
Resilience	Medium	?	?

Ideally, all case studies (A – I) would report that evidence was found for all concepts and components listed in Table 3. But, perhaps only a single case study might highlight a new concept. Opportunities were given to other analysts to determine whether there was evidence in their own case study that would also support the new concept. If so, their I.D. letter was added to the list. Thus, Table 4 provides an overall summary of the case study key findings as well as suggests areas for future concept development.

Table 4: Key Findings from All Case Studies with fictitious results for illustrative purposes

Concept / Component	Evidence Found	I.D. letter	Case Study
C2 Agility			
Endeavour Space Complexity	A	A	Helmand Province
Appropriate (Required) C2 Approach	A – I	B	NATO Operations
C2 Approach Space		C	Rwanda
Allocation of Decision Rights	A – I	D	Estonia
Distribution of Information	A – I	E	Georgia
Patterns of Interaction	A – I	F	Garda
Actual C2 Approach	A – I	G	Haiti
Self-Monitoring	A – I	H	Munich
C2 Approach Agility		I	Vancouver
Flexibility	A – I		
Adaptiveness	A – I		
Responsiveness	A – I		
Versatility	A – I		
Innovativeness	A – I		
Resilience	A – I		

New Concept 1	*C*
New Concept 2	*A, B, D, I*
etc…	*etc…*

4. Case Study Findings

Using completed case study templates as reference, Table 3 was filled out for each case study. However, only one case study from each category is reported here for brevity sake. The complete set of case study templates and tables will be published as part of the SAS-085 final report. This section provides a very brief summary of five case studies along with the associated summary table, followed by a few highlights of how the case study is important in validating and advancing the C2 Agility Model.

A. Helmand Province 2010/11

Military C2 organizations and structures involved in warfighting operations in Helmand, Afghanistan faced many challenges that stem from the need to 1) coordinate activities of multiple supporting commands and assets as well as 2) respond quickly to a variety of incidents in a counter insurgency (COIN) environment. In order to achieve their objective in terms of desired effects and maintain an adequate level of security, these organizations must display a high degree of agility, and adapt to changes and unexpected events characteristic of a complex battlespace. Lives depended on it daily.

Table 5. Helmand Province Case Study Evidence

Concept/Component	**Aug 2010 (Phase 1)**	**Sept 2010 (Phase 2)**	**Oct 2010 (Phase 3)**	**Nov 2010 (Phase 4)**	**Dec 2010 (Phase 5)**	**Jan 2011 (Phase 6)**
C2 Agility						
Endeavour Space Complexity	(Very) High	(Very) High	(Very) High	(Very) High	(Very) High	(Very) High
Appropriate (Required) C2 Approach	Edge	Edge	Edge	Edge	Edge	Edge
C2 Approach Space						
Allocation of Decision Rights	Narrow (isolated)	Narrow (isolated)	Less Narrow (expanding network awareness)	Broad (expanding network awareness)	Broad (expanding network awareness)	Broad (expanding network awareness)
Distribution of Information	Vertical Narrow Push	Vertical Narrow Push	Vertical/Lateral "push-pull"	Lateral "push-pull"	Lateral Push-pull	Lateral push-pull
Patterns of Interaction	Tightly constrained	Tightly constrained	Constrained	Unconstrained	Un-constrained	Un-constrained
Actual C2 Approach	Conflicted	Conflicted	De-conflicted	Edge	Edge	Edge
Self-Monitoring	None	None	None	Recognized the need to change approaches	Recognized the need to change approaches	Recognized the need to change approaches
C2 Approach Agility						
Flexibility	Low	Low	Med	Med High	High	High
Adaptiveness	Low	Low	Med	Med high	High	High
Responsiveness	Low	Low	Med	Med High	High	High
Versatility	Low	Low	Med	Med High	High	High

Innovativeness	Low	Low	Med	Med High	High	High
Resilience	Med High	Med High	Med High	Med High	High	High

This case study examines data collected from a specific NATO/ISAF battlespace in the Upper Gereshk Valley, Helmand Province, Afghanistan from August 2010 to January 2011, an area of responsibility belonging to Task Force Helmand. It involves a variety of specific military commands and sub-commands operating within this battlespace with primary focus on a Danish Battlegroup and its five Component Commands, as well as five Special Operations Forces (SOFs) of different varieties operating in the same battlespace. This includes mentored Afghan and Coalition SOFs.

Table 5 shows that the Endeavour Space Complexity was very high, which required a Co-ordinated C2 Approach. There was a clear progression of the C2 approach through the six-month period as the actual C2 Approach moved from Conflicted to Coordinated. That is, the official collective failed to respond sufficiently to the complex environment in phases 1 and 2, and began to sub-divide into two C2 collectives: official and informal. An informal networked sub-collective began to emerge responding effectively to the complex environment, while the official general collective C2 became increasingly irrelevant. The informal sub-collective matured steadily from phases 3 to 6 with increasing agility, while the official collective C2 became incrementally irrelevant. It was as if the single collective experienced ‘mitosis’ which was driven by the principle that whatever decisions and actions were taken needed to have an effect towards achieving operational objectives.

C. Rwanda Genocide 1994

The case study begins on the 5th of October 1993 with the establishment of the UN Assistance Mission for Rwanda (UNAMIR) by the Security Council with Brigadier General Dallaire as the Force Commander of the military component. It ends on the 19 July 1994, by the Rwanda Patriotic Force (RPF) victory which ended genocide by the Hutu extremists. The UNAMIR can be broken into four major phases: UN Assistance Mission, Violence Escalation, Rwanda Monitoring Mission, and Security and Protection of Refugees and Civilians.

The UN Assistance mission was intended to help implement the Arusha Peace Agreement signed by the Rwandese parties on 4 August 1993. That is, UNAMIR's mandate (Security Council Resolution, 872) was to assist in ensuring the security of the capital city of Kigali; monitor the ceasefire agreement, including establishment of an expanded demilitarized zone and demobilization procedures; monitor the security situation during the final period of the transitional Government's mandate leading up to elections; assist with mine-clearance; and assist in the coordination of humanitarian assistance activities in conjunction with relief operations. This involved 2,548 military personnel, including 2,217 formed troops and 331 military observers, and 60 civilian police; supported by international and locally recruited civilian staff.

On April 6, 1994, the president of Rwanda was killed when his plane was shot down. This event set off a 100-day “tidal wave of violence”. This corresponds to phase 2. While the massacres happened, several foreign powers sent military intervention forces to extract their own nationals from Rwanda.

Phase 3 was a Rwanda Monitoring Role only. April 21, 1994, the UN Security Council voted unanimously to withdraw most of the UNAMIR troops, cutting UNAMIR back to 270 troops. The mandate of UNAMIR was adjusted by Security Council resolution 912 (1994) of 21 April

1994, so that it could act as an intermediary between the warring Rwandese parties in an attempt to secure their agreement to a ceasefire; assist in the resumption of humanitarian relief operations to the extent feasible; and monitor developments in Rwanda, including the safety and security of civilians who sought refuge with UNAMIR. As the slaughter continued, UN peacekeeping forces stood by since they are forbidden to intervene, as this would breach their "monitoring mandate".

Phase 4 involved the Security and Protection of Refugees and Civilians. After the situation in Rwanda deteriorated further, UNAMIR's mandate was expanded by Security Council resolution 918 (1994) of 17 May 1994, to enable it to contribute to the security and protection of refugees and civilians at risk, through means including the establishment and maintenance of secure humanitarian areas, and the provision of security for relief operations to the degree possible. Disputes over costs delayed the troops' deployment. UNAMIR II was authorized in May, 1994 but only a tenth of the authorized troop strength was made available by UN member states as late as July 1994. On June 22, 1994, the U.N. Security Council authorized France to deploy 2500 troops (Operation Turquoise) to Rwanda as an interim peacekeeping force, with a two-month U.N. mandate.

The war ended on July 18, 1994, "The RPF took control of a country ravaged by war and genocide. On 19 July, the RPF succeeded in occupying the whole of Rwanda except for the zone controlled by the French. The RPF victory ended the genocide by the Hutu extremists.

Rwanda case study examined the agility between organizations that worked together toward resolving the tensions and genocide in Rwanda: that is, C2 Agility and C2 Approach Agility within self. Table 6 summarizes the model evidence between the UNAMIR headquarters and the UN Department of Peacekeeping Operations (DPKO). Table 5 shows that the Endeavour Space Complexity moved from medium to high. The source documents provided no indication for the Required C2 Approach. However, the Actual C2 Approach was Collaborative for the most part, except for phase 2 where it was reported to be between Collaborative and Edge. Self-monitoring was performed continuously, and the organizations recognized the need to change approaches in phase 2. C2 Approach Agility was low, except (again) for phase 2 which was high. Note that, very little evidence was found for the agility components from the source documents.

Table 6. UNAMIR HQ – UN DPKO Case Study Evidence

Component/Concept	**Phase 1**	**Phase 2**	**Phase 3**	**Phase 4**
C2 Agility				
Endeavour Space Complexity	medium	high	high	high
Appropriate (Required) C2 approach				
C2 Approach Space				
Allocation of Decision Rights	limited	limited / broad	limited	Limited
Distribution of Information	broad	broad	broad	broad
Patterns of Interaction	As required	As required – significant broad	As required	As required
Actual C2 approach	Collaborative	Collaborative / Edge	Collaborative	Collaborative
Self-Monitoring	Was done continuously	Recognized the need to change C2 approach	Was done continuously	Was done continuously
C2 Approach Agility	low	high	low	low
Flexibility)	Nil	Evidence Found	Nil	Nil
Adaptiveness	Nil	Evidence Found	Nil	Nil
Responsiveness	Nil	Evidence Found	Nil	Nil
Versatility	Nil	Nil	Nil	Nil
Innovativeness	Nil	Nil	Nil	Nil

Resilience	Nil	Nil	Nil	Nil

D. Estonia Cyber Attack 2007

In 2007, the Estonia government decided to relocate a Soviet-era WWII memorial from a central location in the capital city to a military cemetery. However this decision was met by intense opposition from the Russian government and media. There were street riots, the siege of the Estonian embassy in Moscow conducted by Nashi (a Russian political youth movement) that included the Ambassador physically harassed.

It is speculated that a Russian Cyber Attack against Estonia was one opportunity to project Russian power over the Estonians. This would be a broader message to countries in and around Estonia who recently joined NATO perhaps warning them of the consequences of what could happen if they become affiliated with NATO. Russian authorities have denied any involvement.

The attackers determined the phases. Phase 1 occurred between 27 – 29 Apr, Phase 2 Wave 1 on 4 May, and Phase 3 Wave 2 occurred 9 – 11 May. The type and form of attacks were something which the Estonians have never experienced before and had no procedure for dealing with it; at the time of the attack the Estonians had no national Cyber Security Strategy, but did create one the following year in 2008. The Estonians needed to be agile, but lacked Shared Situational Awareness (SSA) and a Cyber Common Operating Picture (COP) to help them analyze and respond to the challenge. The SSA and Cyber COP was created almost on the fly in a dynamic exploratory manner involving national and international organizations, such as Computer Emergency Response Team for Estonia (CERT-EE), Ministry of Defense (MoD), NATO and national and international Information Technology experts. The Estonians experienced different types of attack including psychological, physical and Cyber.

Table 7: Estonia Cyber Attack 2007 Case Study Evidence

Concept/Component	**Phase 1**	**Phase 2 Wave 1**	**Phase 2 Wave 2**
C2 Agility			
Endeavour Space Complexity	High	High	medium - high
Appropriate (Required) C2 Approach	cyber only – co-ordinated or collaborative wider conflict – co-ordinated	cyber only – co-ordinated or collaborative wider conflict – co-ordinated	cyber only – co-ordinated or collaborative wider conflict – co-ordinated
C2 Approach Space			
Allocation of Decision Rights	wide	wide	wide
Distribution of Information	broad	broad	broad
Patterns of Interaction	unconstrained	unconstrained	unconstrained
Actual C2 Approach	cyber only - collaborative wider conflict – de-conflicted	cyber only - collaborative wider conflict – de-conflicted	cyber only - collaborative wider conflict – de-conflicted
Self-Monitoring	none	began to understand effect of defensive actions	began to establish future capabilities based on learning
C2 Approach Agility			
Flexibility	high	high	medium
Adaptiveness	low	low	medium
(Lack of Responsiveness)	high	medium	medium
Versatility	high	medium	medium
(Lack of Innovativeness)	medium	low	low
Resilience	low	low	medium

The Endeavour Space complexity is high and reduces towards the end of the campaign as shown in Table 7. C2 approach is tracked for both the cyber portion of the operation as well as the wider conflict. For the cyber portion, the required C2 Approach was coordinated or collaborative while the actual C2 Approach reached collaborative, thus leaning towards evidence for C2 Agility according to its definition. On the other hand, the wider conflict requires Co-ordinated C2 but only achieved between conflicted and de-conflicted C2, thus suggesting a lack of C2 Agility. Self-monitoring was used to establish future capabilities. In terms of C2 Approach Agility, evidence was found for all the components. Note that ordinal values are given for Lack of Responsiveness and Lack of Innovativeness.

F. Garda Earthquake 2004

Garda Lake Earthquake took place 24 November, 2004, and it was centred in the town of Saló. The collective was the Italian Civil Protection that is an aggregate of virtually every organization that would respond to a civil emergency including individual citizens and voluntary groups. The notion of "Double Identity" is embedded in this culture: that is, everyone could be a member of Civil Protection. Citizens and groups are provided DVD training as well as perform annual training exercises. Needless to say that the people were prepared and the infrastructure was in place just in case an earthquake was to happen, and it did.

This case study could be divided into three phases: Emergency, Stabilization, and Reconstruction. These phases were carried out almost in parallel. Nine hours after the earthquake hit, a decision was made to open the Unified Operational Room (operations centre) in a high school. The Emergency phase gradually shifts into Stabilization and Reconstruction. There are no clearly established boundaries that define such phases, and they often take place in parallel. The priority was given to about 2500 families without a home. By the beginning of November 2005, the situation was declared closed and all the people had returned to their homes.

Table 8: Garda Earthquake 2004 Case Study Evidence

Concept/Component	**Phase 1 Emergency**	**Phases 2 & 3 Stabilization & Reconstruction**
C2 Agility		
Endeavour Space Complexity	High	Medium to low
Appropriate (Required) C2 Approach		
C2 Approach Space		
Allocation of Decision Rights	Broad moving to less Broad	More centralized
Distribution of Information	Broad moving to less Broad	More structured
Patterns of Interaction	Unconstrained moving to more formal interactions	More regular and less intense
Actual C2 Approach	Edge	Collaborative to more Coordinated
Self-Monitoring		
C2 Approach Agility		
Flexibility		
Adaptiveness		√
Responsiveness	√	
Versatility	√	
Innovativeness		√
Resilience	√	√

Although Table 8 does not report on the Required C2 Approach, Self-monitoring, and a few of the C2 Approach Agility components, it is clear that Actual C2 Approach maps well with the

Endeavour Space Complexity. That is, this case study reports the expectation that Edge C2 would be an appropriate response to high complex situations and a collective would move gradually along the diagonal of the C2 Approach Space as the complexity subsides. There is clear evidence that the collective was prepared well in advance for such an event.

H. Munich Olympics 1972

The Munich 1972 Olympics were promoted as the "Happy Games" twenty-seven years after WWII. This was an opportunity for Germany to showcase a completely different image of their new progressive society. Security personnel wore bright coloured uniforms and carried no fire arms. It was to be the best Olympic Games the world had ever seen. However, terrorists took the opportunity to make a statement on the world stage. Unsuccessful rescue attempts led to the death of nine hostages and one police officer.

The collective was not one set entity but organizations moved in and out of the collective over the extent of the operation. At different points in time the collective included Federal, State, and Municipal German Governments, National Army, Border Guard, Munich Police, International Olympic Committee, Organizing Committee, Israeli Government, Arab League, and key individuals from Egypt and Tunisia.

The case study was divided into five phases. Phase 1 was a pre-disturbance phase where there were assessments of potential threats, lessons learned from previous Olympics, management of 'smaller' disturbances, and security at the Olympic Village. Evidence for the C2 Agility model concepts and components are found for this phase as well as the others. The disturbance itself is divided into three phases. Phase 2 was the Hostages in the Apartment where the terrorists attacked the Israeli Team Headquarters, the Collective tries to negotiate with terrorists while Israel upholds their policy not to negotiate with terrorists, two rescue attempts fail, Germany declines support from Israeli's Special Forces but Israeli experts join Crisis Team, and the Olympics are suspended. Phase 3 was moving the Hostages from the Apartment to Airfield where ambush attempt fail but the terrorists were identified. Phase 4 was the Airfield Take-Down a final ambush attempt was aborted resulting in an open gun fire fight. Phase 5, Post-Disturbance, involved changes to Government policy towards terrorists, creation of a counter-terrorism unit, and changes to internal security.

Table 9: Munich Olympics 1972 Case Study Evidence

Concept/Component	**Phase 1** Pre-terrorist attack	**Phase 2** Hostages in apartment	**Phase 3** Apartment to airfield	**Phase 4** At the airfield	**Phase 5** Post-terrorist attack
C2 Agility					
Endeavour Space Complexity	Low	Medium	High	Very High	
Appropriate (Required) C2 Approach	Coordinated	Coordinated	Coordinated	Collaborative	Coordinated
C2 Approach Space					
Allocation of Decision Rights	None	Somewhat Narrow	None	Complete Breakdown	
Distribution of Information	Low (radios only)	Low	None	Incorrect Info	
Patterns of Interaction	None	Somewhat constrained	None (out of control)	Complete Breakdown	
Actual C2 Approach	Conflicted (Independent)	De-conflicted	Conflicted	Worse than Conflicted (Anarchic)	
Self-Monitoring					
C2 Approach Agility					
Flexibility		√			

Adaptiveness	No Evidence	No Evidence	No Evidence	No Evidence	
(Lack of Responsiveness)	High	High	High	High	
(Lack of Versatility)	High	High	High	High	
Innovativeness					
Resilience	No Evidence	√	No Evidence	No Evidence	

Table 9 shows a clear disconnect between the Required C2 Approach and the Actual C2 Approach. It was clear that the collective failed to realize the complexity of the situation, and failed to adopt any of the C2 Approach Agility components: note that a value of "High" is for the "Lack of component". Also note that although there are check marks beside Flexibility and Resilience, these represent isolated incidents in the reported vignettes, and do not refer to the entire phase. The DI value is "Incorrect Information" during Phase 4. Analysts concluded that distributing incorrect information is worse than not distributing any information. Overall, this case study provided evidence for a lack of C2 Agility.

5. Case Study Meta-Analyses

a. Case Study Evidence Summarized

This section examines the C2 Agility Model from the perspective of all case studies. Table 10 summarizes the evidence gathered across the case studies for Endeavour Space Complexity and C2 Approach Space dimensions (and therefore the Actual C2 Approach). This provides confidence that these concepts are legitimate and observable in complex endeavours.

Table 10: Summary of Evidence Found from All Case Studies

Concept / Component	Evidence Found	I.D. Letter	Case Study
C2 Agility	*A, F*		
Endeavour Space Complexity	A – I	A	Helmand Province
Appropriate (Required) C2 Approach	A, D, H, I	B	NATO Operations
C2 Approach Space		C_1	Rwanda - DPKO
Allocation of Decision Rights	A – I	C_2	Rwanda - media
Distribution of Information	A – I	D	Estonia
Patterns of Interaction	A – I	E	Georgia
Actual C2 Approach	A – I	F	Garda
Self-Monitoring	A, C_1, C_2, D, I	G	Haiti
C2 Approach Agility	A, C_1, C_2,	H	Munich
Flexibility	A, C_1, C_2, D, E, G, H	I	Vancouver
Adaptiveness	A, C_1, D, E, F, G		
Responsiveness	A, C_1, D, E, F, G, H, I		
Versatility	A, D, F, G, H, I		
Innovativeness	A, C_2, D, E, F, G		
Resilience	A, D, F, H		

C2 Agility (transition from one approach to another based on the situation complexity) can be inferred from Helmand Province and Garda Earthquake case studies. Note that their I.D. letters are in italics because C2 Agility evidence is not directly from source documents but derived from examining the Required C2 Approach and comparing it to the Actual C2 Approach over time. Helmand Province (Table 5) shows the Required C2 Approach as Edge based on the situation complexity, while the Actual C2 Approach starts as Conflicted, passes through De-conflicted, and ends up as Edge. This is the clearest evidence of C2 Agility. The actual C2 Approach in the Garda case study (Table 8) varies directly with the Endeavour Space Complexity (as the C2 Agility Model would assert). Conversely, Haiti reported Conflicted to De-conflicted C2 when

the complexity was High, and transitioning up to Co-ordinated C2 when the Complexity was Medium to Low. This is opposite to what the model might predict. The Vancouver Olympics employed Coordinated C2 Approach when the situation complexity was low. However, Coordinated C2 (or higher) was just as effective for low complexity situations, but perhaps not as efficient. The Munich case study provided evidence for the lack of C2 Agility.

Although Estonia and Munich were able to make links between Endeavour Space Complexity and Required C2 Approach, there was no evidence of self-monitoring of the Actual and Required C2 Approaches. It seems that the Actual C2 Approach meandered through the C2 Approach Space without any regulation imposed on it. Four out of nine case studies indicated self-monitoring, which is absolutely essential for C2 Agility. Out of the four case studies, only Helmand Province yielded C2 Agility. Of note, Garda Earthquake yielded C2 Agility but did not indicate any evidence for self-monitoring. One possible reason for this is that the concept of self-monitoring was added to the C2 Model long after the Garda Earthquake template was completed.

The second part of Table 10 records the C2 Approach Agility results. All, but one case study, reported evidence for Flexibility and Responsiveness. The Vancouver Olympics case study did not report evidence for Flexibility because there was no opportunity (major disturbance) to exhibit flexibility. The Rwanda UN-DPKO interaction (C_1 and Table 6) did not report any evidence for Responsiveness, although the Rwanda UN-media interaction (C_2 and no Table in this paper for brevity sake) did report evidence. And so strictly speaking the case study as a whole did provide evidence for Responsiveness.

These results would lead us to believe that Flexibility and Responsiveness are vital for C2 Approach Agility where their higher values should correspond to Collaborative and Edge C2 approaches and lower values should correspond to Coordinated and De-conflicted C2 approaches. Upon closer examination, however, only Helmand Province case study matches this expected correlation between Actual C2 Approach and C2 Approach Agility. To illustrate where the expected correlation did not hold, the Munich Olympics reported Flexibility during one of their vignettes, yet the Actual C2 approach was Conflicted. Thus, it is difficult to draw conclusions between Actual C2 Approach and C2 Approach Agility components using these case studies.

In summary, the case studies provide strong evidence for Endeavour Space Complexity and C2 Approach Space and Actual C2 Approach. The Helmand Province case study provides the most convincing evidence for C2 Agility, while the other case studies may be explained using the C2 Agility framework. We also observed that Self-monitoring plays an important role in C2 Agility. Finally, although evidence was found for C2 Approach Agility components, there is less clarity in validating the expected relationship between the component values and the Actual C2 Approach levels.

b. New Concepts and Components

Case study analyst teams were provided an opportunity to identify and report new concepts and components. Recall that Table 4 provides placeholders for these new concepts and components. Once a new concept is reported, other case study analysts may decide whether the concept was present within their study. Each new concept and component is presented in Table 11 and discussed briefly below.

Anticipation (Learning, Training, Exercises) as a component was debated within SAS-085. It certainly enables agility; however, it typically manifests itself before the event or between two events and not during an event where agility would be manifested. And so SAS-085 considered the concepts of Potential and Manifest C2 Agility. Potential C2 Agility would include components that would help the organization prepared to be agile, while Manifest C2 Agility would be measurable and observable agility during an event. Potential C2 Agility is linked to the concept of Requisite Maturity in that the collective must possess a certain C2 Maturity to manifest C2 Agility and C2 Approach Agility. Anticipation could be categorized as part of Potential C2 Agility because it occurs typically between events. On the other hand, a Commander may engage in some anticipatory behaviour during the event.

Table 11: New Concepts and Components Identified from Case Studies

New Concept / New Component	Evidence Found	I.D. Letter	Case Study
Anticipation (Learning, Training, Exercises) ***component***	F, I		
Role of Leadership in achieving, determining, or maintaining C2 Agility or C2 Approach Agility	A, C, F, G, H, I	A	Helmand Province
Collective size changes over time	C, F, G, H	B	NATO Operations
Different entities within Collective have different C2 approaches	C, D, G, I	C	Rwanda
'Comfortable' C2 Approach creates tension for transitioning to the appropriate (required) C2 approach	G, I	D	Estonia
Risk Assessment	C	E	Georgia
Importance of Competency ***component***	D, E, F	F	Garda
Requisite Variety in Skills and Resources, necessary to cope with the complexity and dynamics of the situation	D, E, F	G	Haiti
Trust and interpersonal relationships	C, F, H	H	Munich
Role of Compromise, key enabler for flexibility, Advantage Agility Components	G	I	Vancouver
More Research Required to Understand Conflicted C2	H		
Politically Driven C2 Approach and other external influences that may determine Actual C2 Approach location in the C2 approach space	I		
Off diagonal approaches	C, G, I		
C2 Agility and C2 Approach Agility as an emergent phenomenon (not pre-designed)	A		

The role of Leadership in achieving, determining, or maintaining C2 Agility or C2 Approach Agility was evident in six out of nine case studies. Case study H (Munich Olympics) is highlighted in red to denote that poor Leadership led to a lack of C2 Agility and C2 Approach Agility. The Vancouver Olympics was the most obvious case of this new concept where political leadership mandated the Interagency Security Unit to be Collaborative, and every effort was made to attain this goal.

Collective size changing over time is a new concept that impacts C2 Agility and C2 Approach Agility. Helmand Province and Garda Earthquake collectives produced Edge C2 as required. These collectives were relatively small and homogeneous compared to other case study

collectives where larger collectives required more controls to govern and manage the internal workings of the organization, thus diverting energy from becoming more agile.

C2 Approach homogeneity amongst entities within the collective enables agility, but different entities within the collective that have different C2 approaches tend to inhibit agility. The Rwanda case study reported that UNAMIR employed different C2 approaches with different organizations depending on the maturity level of the contingent as well as the trust level between leaders: Conflicted C2 with Banglaseshi contingent, Deconflicted C2 with France, Coordinated C2 with Ghana, and Collaborative C2 with Belgium. Similarly, national, provincial, and municipal police along with military forces and other security organizations for the Vancouver Olympics recognized that they all had very different ways of operating. And so, several exercises were conducted before the Olympics to develop a common C2 approach for this event or, at the very least, understand the differences.

The notion of a 'Comfortable' C2 Approach was highlighted in both the Haiti and Vancouver case studies. That is, an entity may be familiar with a certain C2 Approach (e.g., De-conflicted) and then they are put into situations that are more edge-like. This creates a reluctance to change to the new approach. Note that, the reverse is true if an entity is used to being edge-like and the situation requires a more de-conflicted approach, there will still be some reluctance to change.

Risk Assessment is a new concept observed during the Rwanda Genocide case study analysis. General Dallaire weighed the risks of his career against the potential of saving lives before divulging the truth of the Genocide to the media and therefore focusing world opinion on the Rwanda operation. Here we see risk assessment as part of individual agility. This relationship between risk and agility requires further exploration.

The importance of Competency component for agility was evident in Estonia, Georgia, and Garda case studies. An agile organization must have competency in not only performing tasks but also allocating decision rights, distributing information, facilitating interactions between entities within the collective. For Estonia and Georgia, we see special skills (computer hacking) were employed to cope with the nature of the conflict. Requisite Variety in Skills and Resources necessary to cope with the complexity and dynamics of the situation is related to this new component.

Garda showed that Trust and Interpersonal relationships are key human factors variables related to agility. Again H is red to indicate that the Munich case study demonstrated distrust and non-healthy interpersonal relationships amongst entities would lead to a lack of C2 Agility.

The term "Conflicted C2" did not seem appropriate in the Munich case study. Although ADR was none, DI was none, and PI was constrained (i.e., a region at the origin of the C2 Approach Space) entities within the collective were acting more independently than in conflict and were making decisions on their own: analysts coined the term "Independent C2". Case study analysts used the term "Anarchical C2" when DI was "somewhat broad" but erroneous. More thought is required to determine the characteristics of ADR, DI, and PI that would characterize the differences between Independent C2 and Conflicted C2.

Politically driven C2 Approach and other external influences may also determine the Actual C2 Approach in the C2 Approach Space that the collective adopts. Recall that the definition of C2 Agility has situation complexity driving the transition between approaches. However, the Vancouver case study clearly showed that there may be other drivers such as directives that

come from higher authorities. Interestingly, while the Olympics' strategic level mandated a Collaborative C2 Approach and the situation complexity seemed to suggest a De-conflicted C2 Approach, the Actual C2 Approach ended up somewhere between these two extremes. This phenomenon has been explored using modeling and simulation in (Farrell, 2011). For the Vancouver Olympics case, a strategic directive was made that the ISU would be Collaborative. And so, this directive was a strong contributor to the regulation of the Actual C2 Approach along with the Endeavour Space Complexity. Note that the ISU did not reach Collaborative C2 (as defined by SAS-065) but attained Coordinated C2: meanwhile the Required C2 Approach level would be De-conflicted C2 since the complexity was low.

Rwanda, Haiti, and Vancouver case studies yielded off-diagonal approaches, or at least a range of values that included off-diagonal approaches. This speaks to the difficulty of identifying more precise values of ADR, DI, and PI within the source documents. It also speaks to the dynamic nature of C2 Approachesin that the collective is rarely in one position in the C2 Approach Space over time as well as different entities will have different individual values at any given time, thus making ADR, DI, and PI difficult to measure or aggregate over the entire collective and over time.

The Helmand Province case study reported C2 Agility and C2 Approach Agility as an emergent phenomenon rather than pre-designed before the operation, which would be expected for military endeavours. In many ways, SAS-085 has formalized what successful military collectives and operations have done instinctively.

6. Conclusions and Recommendations

This paper presented an abridged version of the Case Study validation findings for SAS-085's C2 Agility Model. Case study analyst teams completed a case study template as well as very specific data collection Tables 3 and 4 that facilitated a meta-analysis across all case studies.

Table 10 summarized the evidence for the C2 Agility Model concepts and components for all case studies. There is evidence for all concepts and components thus providing 'face' validity in the C2 Agility Model. The confidence level in the evidence gathered is not overwhelming because evidence was collected from source documents that did not explicitly use the model's terms and definitions. And so, the case study analysts had to infer the existence and value of the concepts and components based on their intimate knowledge of the case.

Table 11 provided a list of new concepts and components that may be considered for integration into the C2 Agility Model:

- Anticipation as an agility component
- Role of Leadership
- Collective Size changing over time
- Each entity operating with a different C2 Approach
- 'Comfortable' C2 Approach
- Risk Assessment
- Competency as an agility component
- Skill and Resources Requisite Variety
- Trust and Personal Relationship
- Role of Compromise
- More research on Conflicted C2

- Politically driven C2 Approach
- Off-diagonal C2 Approaches
- C2 Agility and C2 Approach Agility as an emergent phenomenon

It is recommended that the case study findings be compared to experimentation results, as it is hoped that face validity and empirical validity will complement each other and, by doing so, validate the C2 Agility Model. The next recommendation would be to begin the refinement of the C2 Agility Model by cautiously integrating the new concepts and components. Some concepts are ready to be integrated while others need further development. The final recommendation is to look for opportunities for further evidence gathering as well as C2 Agility Model exploitation. In some ways, these two activities go hand in hand in that, ideally, the C2 Agility Model could be taught (made into doctrine, trained, and exercised) for a collective that is about to embark on a complex endeavour, so that they are familiar with all the terminology. Once the mission is completed, evidence may be gathered from Lessons Learned documents that use C2 Agility Model terminology.

7. Acknowledgements

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8. Case Study Leads

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F. Ms. Claudia Baisini, Swedish National Defence College (Garda Earthquake 2004)
G. Dr. Richard E. Hayes (Haiti Earthquake 2010) Evidence Based Research
H. Dr. Philip S. E. Farrell, Defence R&D Canada – Toronto (Munich Olympics 1972)
I. Dr. Philip S. E. Farrell, (Vancouver Olympics 2010) Defence R&D Canada – Toronto

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SAS-085 C2 Agility Model Validation Using Case Studies

18th ICCRTS: C2 in Underdeveloped, Degraded and Denied Operational Environments

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June, 2013

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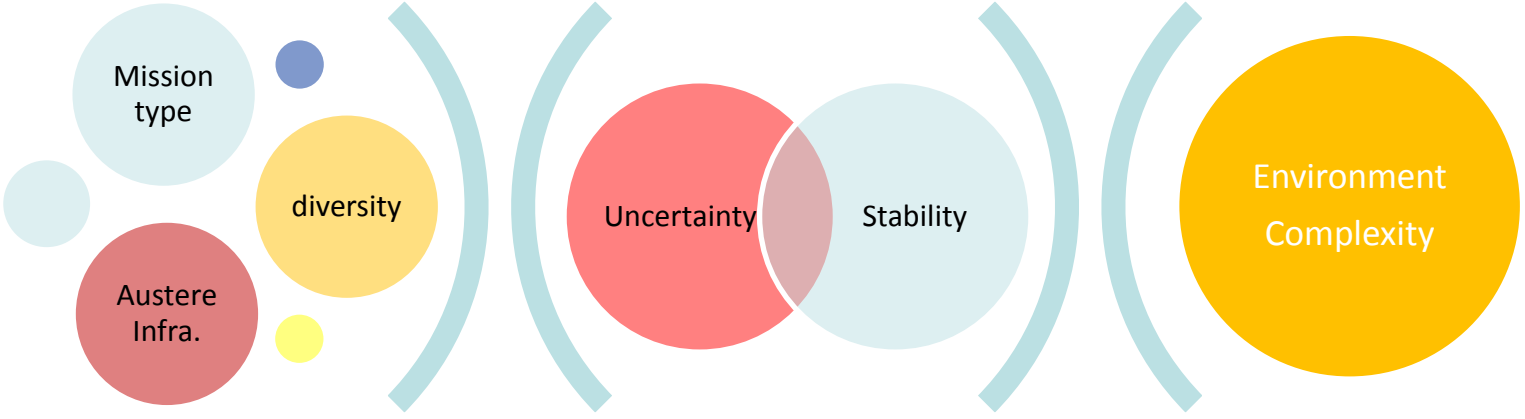
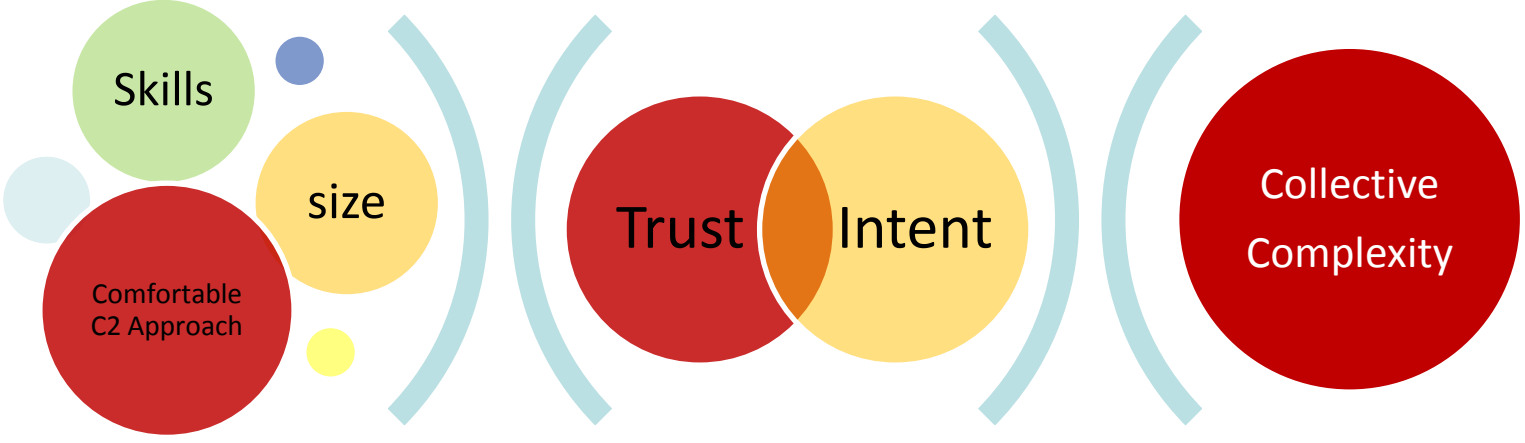
Case Studies

- C2 Agility in Brief
- Case Study Plan
- Case Study Evidence
- Hypotheses Findings
- Conclusions

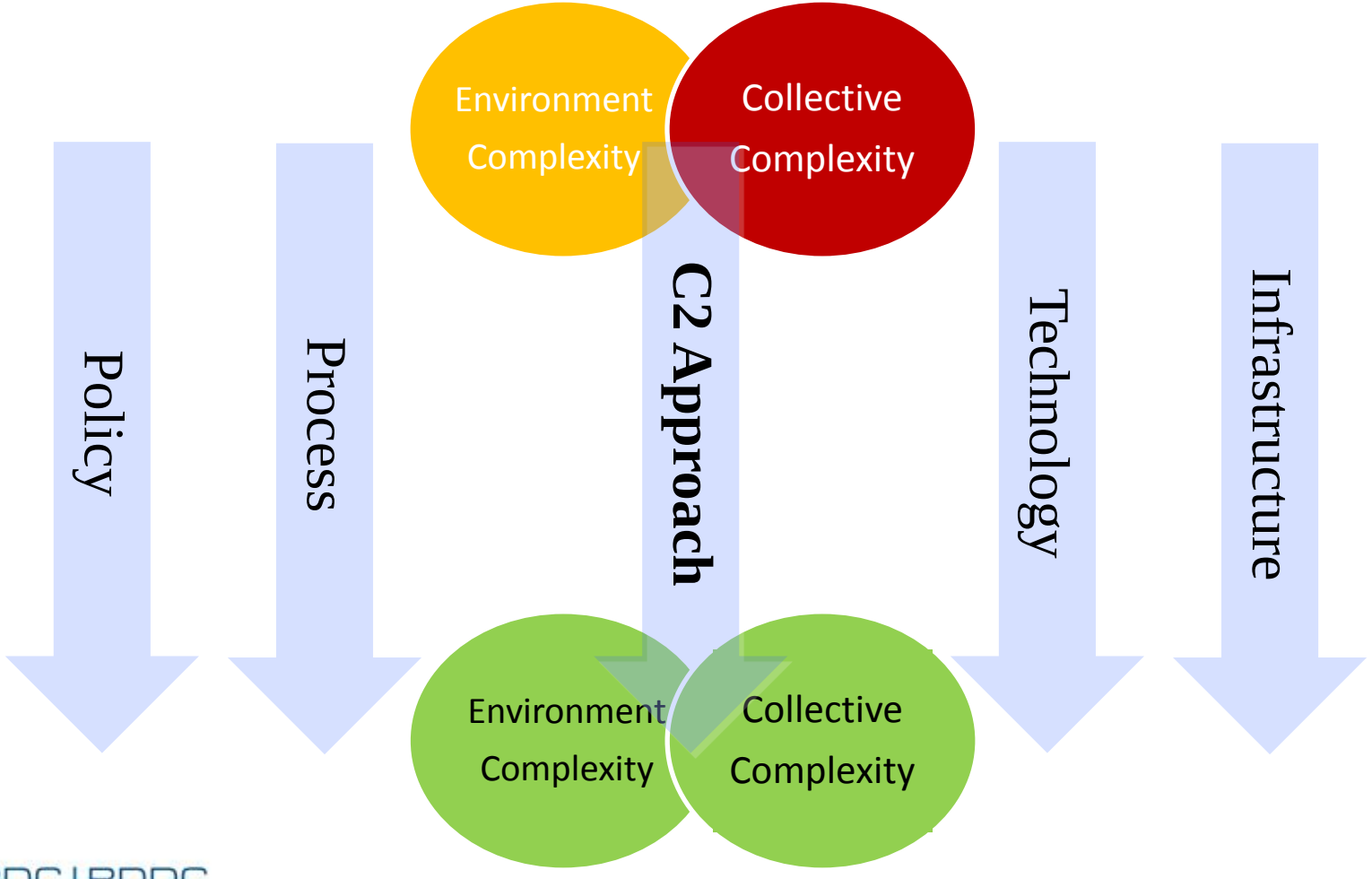
C2 Agility in Brief – Environment is complex!



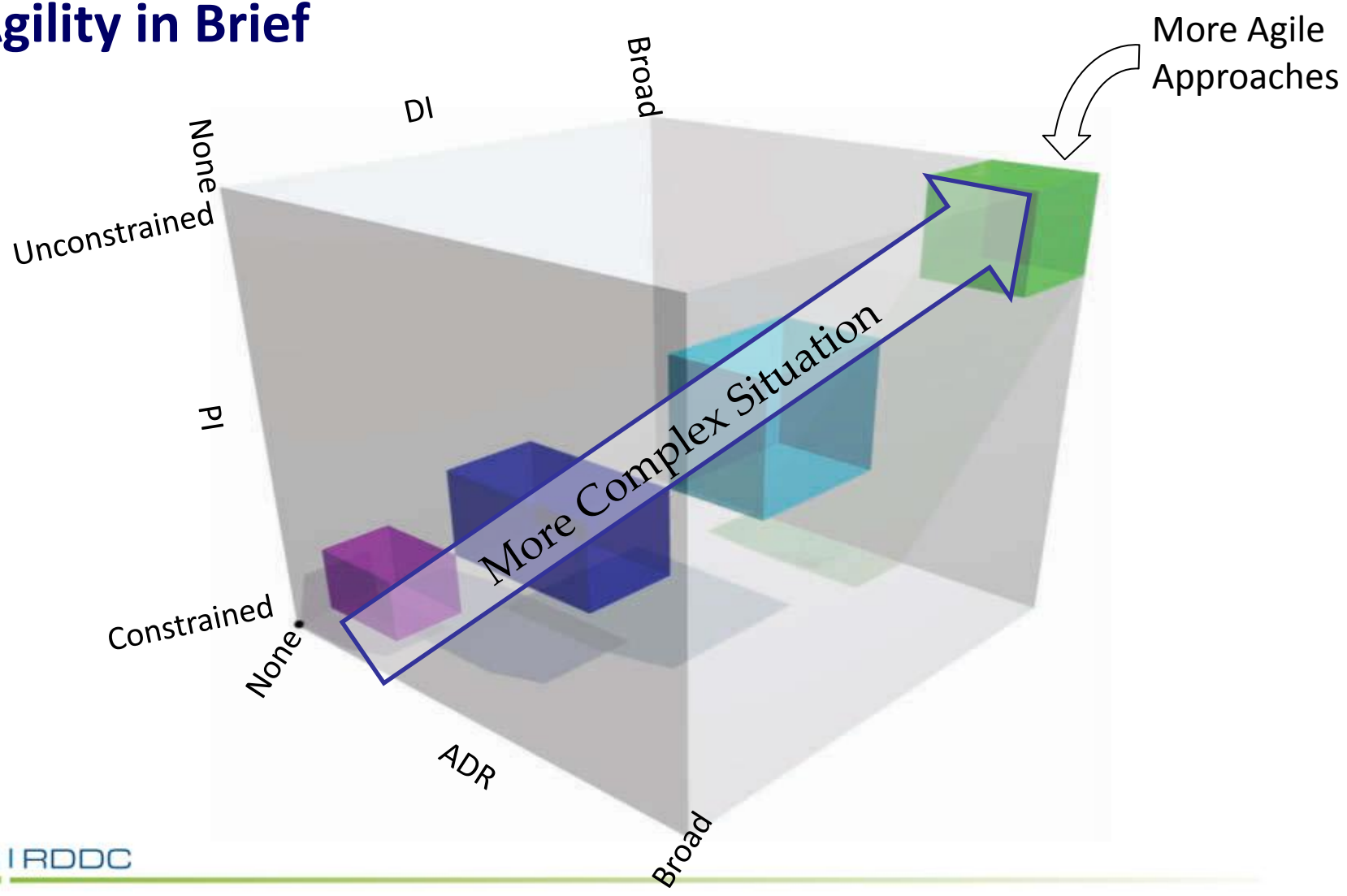
C2 Agility in Brief – Collective is complex!



C2 Agility in Brief



C2 Agility in Brief



C2 Agility in Brief

- C2 Manoeuvre Agility - transitioning from current to required approach to maximize effectiveness and efficiency
  - Situation complexity, Allocation of Decision Rights, Patterns of Interaction, Distribution of Information, self-monitoring.

- C2 Approach Agility - the agility of a C2 Approach
  - Flexibility, Responsiveness, Resilience, Versatility, Adaptiveness, Innovative.

Case Study Plan

- Detailed analyses of historical situations where evidence is sought that may confirm (or not) concepts, notions, or hypotheses

- Advantage: any conclusions drawn from the analysis pertain to real situations, thus providing “face” validity.

- Disadvantage: these conclusions pertain only to those situation(s) being analysed, and therefore it becomes difficult to generalise and extrapolate to other situations.

Case Study Plan

Objectives for conducting Case Study analyses are to:

1. Find evidence for key concepts, components, constraints, and behaviours related to C2 Approach Agility and C2 Manoeuver Agility in the cases.
2. Help clarify the language of C2 Agility
3. Opportunity to demonstrate and verify that the model, in fact, occurs in the real world
4. Contribute to validation by testing C2 Agility-related hypotheses

Case Study Plan

- Develop a Template that reflects C2 Agility model
- Collect Evidence based on Template
- Conduct Meta-analysis looking for:
  - Evidence across multiple studies
  - Evidence of other notions for C2 Agility model

Case Study Plan

The first template was designed to capture relevant source data in one location.

I: Executive Summary
II: Identify the Focus of and the Boundaries for the Case Study
III. Describe the Challenge or Opportunity that gave rise to the need for C2 Approach and C2 Manoeuver Agilities.
IV: What would have been the consequences of a failure to act in a way that demonstrates C2 Approach Agility and C2 Manoeuver Agility?
V: Was C2 Approach Agility and C2 Manoeuver Agility Manifested? If so, How?
VI: Which Enablers and Inhibitors of C2 Approach Agility were observable?
VII: What C2 Approaches were relevant (i.e., did different situation complexity levels require a corresponding different C2 Approach)? How can C2 Manoeuver Agility be inferred from what was reported or observed?
VIII: What interesting and important vignettes are included or can be derived from the case study to help create illustrative stories?
IX: Case Study Assumptions and Limitations:
XI: Bibliography

Case Study Plan

The second template was designed to summarize evidence for each notion, sub-concept, and variable for each case study.

Concept/Component	
C2 Manoeuver Agility	Transitioning from one approach to another
Endeavour Space Complexity	Endeavour Space Complexity values: low, medium, and high
Appropriate (Required) C2 Approach	Labels: De-conflicted, Coordinated, Collaborative, Edge
C2 Approach Space	ADR, DoI, and PoI
Allocation of Decision Rights	Allocation of Decision Rights varies from None to Broad.
Distribution of Information	Distribution of Information varies from None to Broad.
Patterns of Interaction	Patterns of Interaction varies from Constraint to Unconstraint.
Actual C2 Approach	Labels: De-conflicted, Coordinated, Collaborative, Edge
Self-Monitoring	Ability to know where entity is in the space and when to move
C2 Approach Agility	Enabler (or opposite) values: low, medium, and high.
(Lack of) Flexibility	Ability to exceed in multiple ways
(Lack of) Adaptiveness	Ability to change work processes
(Lack of) Responsiveness	Ability to react to changes in the environment
(Lack of) Versatility	Ability to maintain effectiveness across many conditions
(Lack of) Innovativeness	Ability to do new things or old things in new ways
(Lack of) Resilience	Ability to adjust and recover from “self”-damage

Case Study Plan (fictitious input)

Concept/Component	Phase 1	Phase 2	Phase 3
C2 Manoeuver Agility			
Endeavour Space Complexity	High	Medium	Low
Appropriate (Required) C2 Approach	Collaborative	Coordinated	De-conflicted
C2 Approach Space			
Allocation of Decision Rights	Somewhat broad	Narrow	Narrow
Distribution of Information	Broad	Broad	Not as Broad
Patterns of Interaction	Constrained	Constrained	Constrained
Actual C2 Approach	Between Collaborative and De-conflicted	Between Coordinated and De-conflicted	Closer to De-conflicted
Self-Monitoring	None	√	√
C2 Approach Agility			
Flexibility	√	?	?
Adaptiveness	√	√	?
(Lack of Responsiveness)		High	?
Versatility	√	√	?
(Lack of Innovativeness)	√	√	Low
Resilience	Medium	?	?

Case Study Plan

Complex Battlespace

A. ***Helmand Province,*** Dr. William Mitchell, Royal Danish Defence College, **Denmark**

B. ***Comprehensive Approach in NATO Operations,*** Cdr Marten MEIJER PhD, C2 CoE, ***NLD***

Peace-keeping and Personal Agility

C. ***Rwanda Genocide 1994,*** Micheline Bélanger, Defence R&D Canada – Valcartier, ***Canada***

Cyber Warfare

D. ***Estonia Cyber Attack 2007,*** Prof. Michael Henshaw, Loughborough University, ***UK***

E. ***Georgia,*** Douglas J. Ball, M.D., UNC Chapel Hill Gillings School of Global Public Health, ***USA***

Natural Disasters

F. ***Garda Earthquake 2004***, Claudia Baisini, Swedish National Defence College, LTC Arne Norlander, **Sweden**

G. ***Haiti Earthquake 2010,*** Dr. Richard Hayes, Evidence Based Research, **USA**

Major Events

H. ***Munich Olympics 1972,*** Dr. Philip S. E. Farrell, Defence R&D Canada – Toronto, ***Canada***

I. ***Vancouver Olympics 2010,*** Dr. Philip S. E. Farrell, Defence R&D Canada – Toronto, ***Canada***

Case Study Evidence

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- Henshaw, M., Tetlay, A., & Siemieniuch, C. (2013). *SAS-085 Case Study – Estonia: Estonia Cyber Attack in Spring 2007*. Engineering System of Systems Group, School of Electronic, Electrical and Systems Engineering Loughborough University (UK), Loughborough, UK.
- Meijer, M. (2012). *Consequences of the NATO Comprehensive Approach for Command and Control*. Paper presented at the 17th International Command and Control Research and Technology Symposium: Operationalizing C2 Agility. Washington D.C., USA.
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- Basini, C. (draft). *Italian Civil Protection's Operation after the Garda Earthquake, Province of Brescia, 2004 : A Case Study for NATO SAS085 on C2 Agility and Requisite Maturity*. Swedish National Defence College.
- Banbury, S., Kelsey, S. R., & Kersten, C. (2011). Evaluating C2 Approach Agility in Major Events: Final Report (CONTRACT #: W7714-083663/001/SV No. DRDC CR 2011-004). Scientific Authority Dr. Philip S. E. Farrell. Centre for Operational Research and Analysis (CORA), Ottawa, Ontario, Canada: Defence R&D Canada.
- Jobidon, M.-E., Fraser, B., Smith, D., & Farrell, P. S. E. (2011). *Analysis of GM approach agility during the Vancouver 2010 Olympic Games* (Technical Memorandum). Toronto: DRDC Toronto TM 2011-124.
- Farrell, P. S. E., Jobidon, M.-E., & Banbury, S. (2012). *Organizational Agility Olympic Event Case Studies.* Paper presented at the 17th International Command and Control Research and Technology Symposium: Operationalizing C2 Agility. Washington D.C., USA.
- Bélanger, M. (in review). *The difficulty to document agility evidences from a C2 perspective.* Paper presented at the 18th International Command and Control Research and Technology Symposium: C2 in Underdeveloped, Degraded and Denied Operational Environments. Alexandria, VA., USA.
- Farrell, P. S. E., Baisini, C., Bélanger, M., Henshaw, M., William, M., Norlander, A. (in review). *SAS-085 C2 Agility Model Validation Using Case Studies. .* Paper presented at the 18th International Command and Control Research and Technology Symposium: C2 in Underdeveloped, Degraded and Denied Operational Environments. Alexandria, VA., USA.

Case Study Evidence

Concept / Component	Evidence Found	I.D.	Case Study
C2 Maneouvre Agility	**A, F**		
Endeavour Space Complexity	A – I	A	Helmand Province
Appropriate (Required) C2 Approach	A, D, H, I	B	NATO Operations
C2 Approach Space		C_1	Rwanda - DPKO
Allocation of Decision Rights	A – I	C_2	Rwanda - media
Distribution of Information	A – I	D	Estonia
Patterns of Interaction	A – I	E	Georgia
Actual C2 Approach	A – I	F	Garda
Self-Monitoring	A, C_1, C_2, D, I	G	Haiti
C2 Approach Agility	**A, C1, C2,**	H	Munich
Flexibility	A, C_1, C_2, D, E, G, H	I	Vancouver
Adaptiveness	A, C_1, D, E, F, G		
Responsiveness	A, C_1, D, E, F, G, H, I		
Versatility	A, D, F, G, H, I		
Innovativeness	A, C_2, D, E, F, G		
Resilience	A, D, F, H		

Case Study Evidence

Other C2 Agility Model Concepts

Concept / Component	Evidence Found	I.D.	Case Study
Anticipation, Learning, Training, Exercises	F, I		
Role of Leadership	A, C, F, G, H, I	A	Helmand Province
Collective size changes over time	C, F, G, H	B	NATO Operations
Entities with different C2 approaches	C, D, G, I	C_1	Rwanda - DPKO
'Comfortable' C2 Approach	G, I	C_2	Rwanda - media
Risk Assessment	C	D	Estonia
Importance of Competency	D, E, F	E	Georgia
Requisite Variety in Skills and Resources	D, E, F	F	Garda
Trust and interpersonal relationships	C, F, H	G	Haiti
Role of Compromise	G	H	Munich
Understanding Conflicted C2	H	I	Vancouver
Politically Driven C2 Approach	I		
Off diagonal approaches	C, G, I		
Agility as an emergent phenomenon (not pre-designed)	A		

Hypotheses Findings

1. Each NATO NEC C2 Maturity Model Approach is located in a distinct region of the C2 Approach Space
   - By definition
2. No one approach is always the most appropriate
   - Evidence Found
3. More network-enabled approaches are more appropriate for Complex Endeavors; while less network-enabled approaches are more appropriate for less complex missions/circumstances
   - By definition
4. More network-enabled approaches are more agile (have greater C2 Approach Agility)
   - Unclear. However, Munich (conflicted or worse) does show lack of C2 Approach Agility
5. The dimensions of the C2 approach Space are positively correlated with agility
   - Unclear. This is likely related to the agility metric
6. More network-enabled approaches are better able to maintain their intended positions in the C2 Approach Space
   - Evidence found to support the notion of maintaining the appropriate approach whether they were more networked or not.

Hypotheses Findings

7. On-diagonal (balanced) approaches are more agile
   - No evidence
8. Increasing C2 Maneuver Agility increases agility
   - Unclear. should read the ability to transition from one approach to the appropriate approach increases the ability to successfully cope
9. More mature c2 capability is more agile than the C2 Approach Agility of the most network-enabled approach available
   - No evidence
10. Self monitoring is required for C2 Maneuver Agility
    - Evidence Found
11. : The six components (enablers) of agility are collectively exhaustive and thus all instances of observed agility can be traced to one or more of these components (enablers)
    - By definition. Evidence was found between C2 Approach Agility and enablers. However, other enablers were found (e.g., leadership, trust)
12. Each of these components (enablers) is positively correlated with agility
    - Evidence Found

Conclusions

- Evidence was found for the C2 Agility Conceptual Model, thus providing face validity for the model
- Other concepts and components were identified that may be under consideration for insertion into the C2 Agility Conceptual Model
- The Case Study results (face validity) will be compared to experimental results (empirical validity)

Questions?

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